Proposed Spatially Distributed Rain Gauges to Improve Rainfall Database in Jaffna District

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Abstract

Adequate knowledge of rainfall is important in order to understand the changes and variations in the rainfall of a particular location. Jaffna Peninsula consists of the Peninsula and seven inhabited Islands. First rain gauge station was established in 1870 and gradually all other rain gauge stations were established all over the Peninsula. There were fourteen rainfall data colleting stations during the period of 1960 which were spatially distributed in Thenmarachchi, Delt, Jaffna, Island North, Nallur, Vadamarachchi North, Valikamam East, Valikamam North, and Valikamam South. All the instruments in those stations were lost due to the prevailing war in these areas and were not functioning till 2013 except only one station which is functioning in Jaffna meteorological station. The gap on unavailability of spatial rainfall data misleads inappropriate understanding accurate changes in rainfall of the location. Monthly data from 1887 to 2012 of Jaffna meteorological station was used for analysis. The probability of exceedance was also analyzed. The frequency analysis of annual series was carried out to obtain a relationship between the magnitude of each event and its probability of exceedence. Annual rainfall data from 1961 to 1990 and from 2001 to 2010 were considered separately to see the century scale fluctuations. As per the record, only one station which is functioning in Jaffna district shows meteorological observations diminished to unrecoverable levels. Time series analysis of 122 years of rainfall data shows normal distribution. Rainfall amount during this period varied between 571.2 mm to 1964.9 mm with the average of 1255 mm and the 75% of probability of rainfall was 1020 mm. During the period of 1961 to 1990, this value was 1010 mm but, the rainfall of 1220 mm was received on the probability plot against 2001 to 2010. This variation in the rainfall in the 75% of probability could be due to the short time series. The probability plot was used to get return period value. The time series analysis of rainfall amount could be performed well if the rainfall data are spatially distributed all over the Peninsula which subsequently could be used to carry out planning activities successfully.

Key words: Rainfall, Jaffna, Probability, Frequency

Introduction

Jaffna peninsula consists of the peninsula and seven inhabited Islands. North, East and West boundaries of the district are Indian ocean, South is Jaffna lagoon and Kilinochchi District. The land in Jaffna District could be characterized as flat with less than 5% slope. There are over 631ponds and 2,433 ditches scattered all over the district with connecting channels to conserve rainwater. The total land area of the district is 983.6 km^2.

Adequate knowledge of rainfall is important in order to understand the changes and variations in the rainfall of a particular location. The total rainfall received in a given period at a location is highly variable from one year to another. Hence, the rainfall data analysis is important in order to planning of drainage, understand the present pattern of agriculture, and to determine the proper sequence of agricultural operations and suitable cropping pattern. The knowledge also will allow predicting the behavior of this natural resource. This prediction of rainfall help for future planning by defining crop yields expected from the region much more accurately and for adaptation measures.It is also very important in understanding the rainfall pattern in the regions where it is the main source for recharge of the groundwater. Hence, the objective of the study was

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selected as gathering information on installation period of spatial distribution of rain gages in Jaffna district and analyzing available rainfall data to estimate rainfall depths that can be expected for selected probabilities or return period from the probability plot.

Materials and Methods

Collection and analysis of rainfall data

Installation period of spatial distribution of rain gages was gathered from the available rainfall data. Monthly data from 1887 to 2012 from the Jaffna meteorological station was used for analysis. Annual rainfall for different period was observed to see the variation as time series with average rainfall. Homogeneity test was performed based on the cumulative deviations from the mean (Buishand, 1982). Subsequently it was graphically checked for normal distribution. The probability of exceedance was analyzed. The frequency analysis of annual series was carried to obtain a relationships between the magnitude of each event and its probability of exceedence according to Haan (1986). Annual rainfall data from 1961 to 1990 and from 2001 to 2010 were considered separately to see the century scale fluctuations. Before analyzing partially, the data was checked for homogeneity. The rainfall data of 1991 to 2000 were not taken for the analysis because of the missing data of 42 months due to displacement in the district. The data of the time series shows as homogeneous and there was no systematic pattern in the deviations from their mean.

Results and Discussion

Spatial distribution of rainfall

First rainfall station in Jafffna District was established 1870 and gradually established all over the Peninsula. There were fourteen rainfall stations during the period of 1960 which were spatially distributed at Thenmarachchi, Delt, Jaffna, Island North, Nallur, Vadamarachchi North, Valikamam East, Valikamam North, and Valikamam South areas (Rajendrum *et al.*, 2000). The table 1 shows the spatial distribution of rain gauge stations in Jaffna district. However, all the instruments were lost in these stations due to the war and were not functioning till. There is only one station is functioning in Jaffna meteorological station at present resulting lack of meteorological data available. The gap on unavailability of spatial rainfall data misleads inappropriate understanding on the changes in rainfall in a location. According to Kadupitiya *et al.* (2012), the result of climate change vulnerability mapping for Sri Lanka, shows that exposure index, sensitivity index, adaptive capacity index, vulnerability and the rank were as 0.362, 0.024, 0.507, -0.121 and 7 respectively, for Jaffna district. Out of twenty five districts, Jaffna District was classified into low vulnerability to climate change. Anyhow re-establishment of rainfall stations with spatial distributions is very essential to forecast the rainfall variations and to recommend the adaptation measures and planning activities in the future.

Table 1. Distribution of rainfall stations in Jaffna district

Period	Number of rainfall stations	Period	Number of rainfall stations
1871 - 1880	1	1941 - 1950	10
1881 - 1890	2	1951 - 1960	14
1891 - 1990	7	1961 - 1970	7
1991 - 1910	8	1971 - 1980	7
1911 - 1920	8	1981 - 1990	6
1921 - 1930	9	1991 - 2000	1
1931 - 1940	10	2001 - 2010	1

Rainfall data analysis

There were significant changes in rainfall amount which varied between 571.2 mm (1974) to 1964.9 mm (2001). The average rainfall for the time series of the year data from 1887 to 2012 was 1255 mm. The cumulative deviations from the mean of the total annual rainfall data for the time series 1887 to 2012 for Jaffna shows cumulative deviation fluctuate around zero and are far off the lines where the homogeneity is rejected. Hence, the data of the time series considered as homogeneous. Also there was no systematic pattern in the deviations from their mean. The probability plot indicates that the data was normally distributed. The Figure 1 shows the probability plot of rainfall using 122 years of data and 30 years of data from 1961 to 1990. The 75% of probability of rainfall was 1020 mm and from 1961 to 1990, the 75% of probability of rainfall was 1010 mm. The rainfall of 1220 mm was received on the probability plot against 2001 to 2010. This variation in the rainfall of 75% of probability could be due to the short time series.

The probability plot could also be used to get return period value of certain rainfall. For example the rainfall for 2010 was 1800 mm. While plotting this rainfall in the probability plot, the probability of exceedence was 14% or this means that less rainfall occurs only on average in 14 out of 100 years or, probability of non exceedence was 14%. The return period for which the rainfall was less than one in 2010 was (1/.14) 7.14 years. This exercise could be used to any rainfall amount; wet or dry years, and get the probability and the return period.

The derived probability and return period values could be used for planning activities and adaptation measures for flood or drought. The runoff water must be carefully directed to store in the surface tanks. Since the seasonal rainfall is the only source for recharging the groundwater aquifer, analysis of rainfall is very imperative to take adaptation measures for the proper management of groundwater. Rainfall trend analysis provides useful data for water resource planning and management. As an adaptation measure in Jaffna District, all the possible surface ponds must be deepen to hold rainfall runoff during rainy season. The natural drainage channels which discharge the runoff water to ponds and ditches were disturbed due to the urbanization and the development activities. Hence, there should be some measures to manage the probability exceedance rainfall without having flood. For all these proposed activities, spatially distributed rain gauges are important in Jaffna district.

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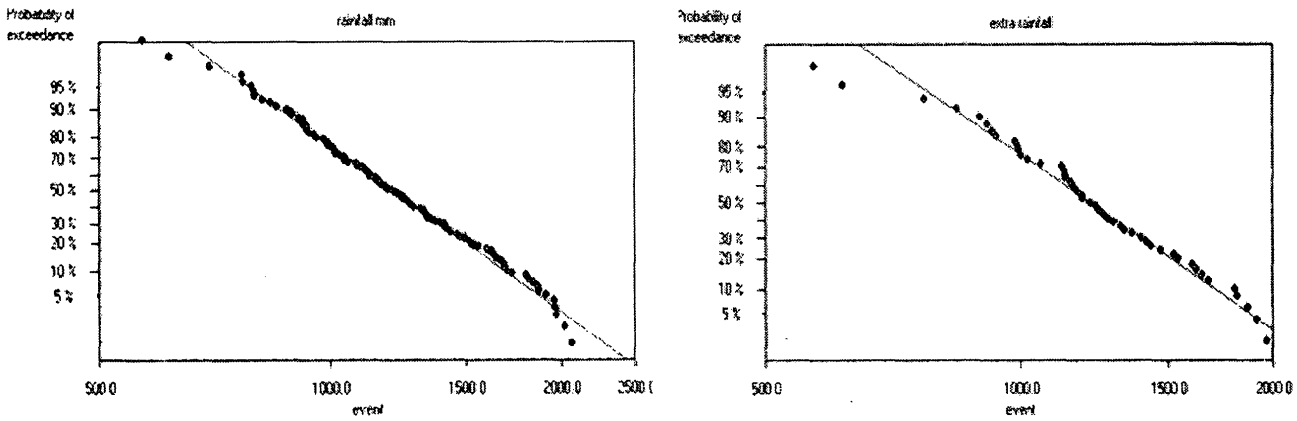

Rainfall data from 1887 to 2012

Rainfall data from 1961 to 1990

Figure 1. Probability plot for total rainfall during two different periods.

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